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TWO NEW SUBSPECIES OF PHYLLORHYNCHUS,
THE LEAF-NOSED SNAKE,
WITH NOTES ON THE GENUS

BY

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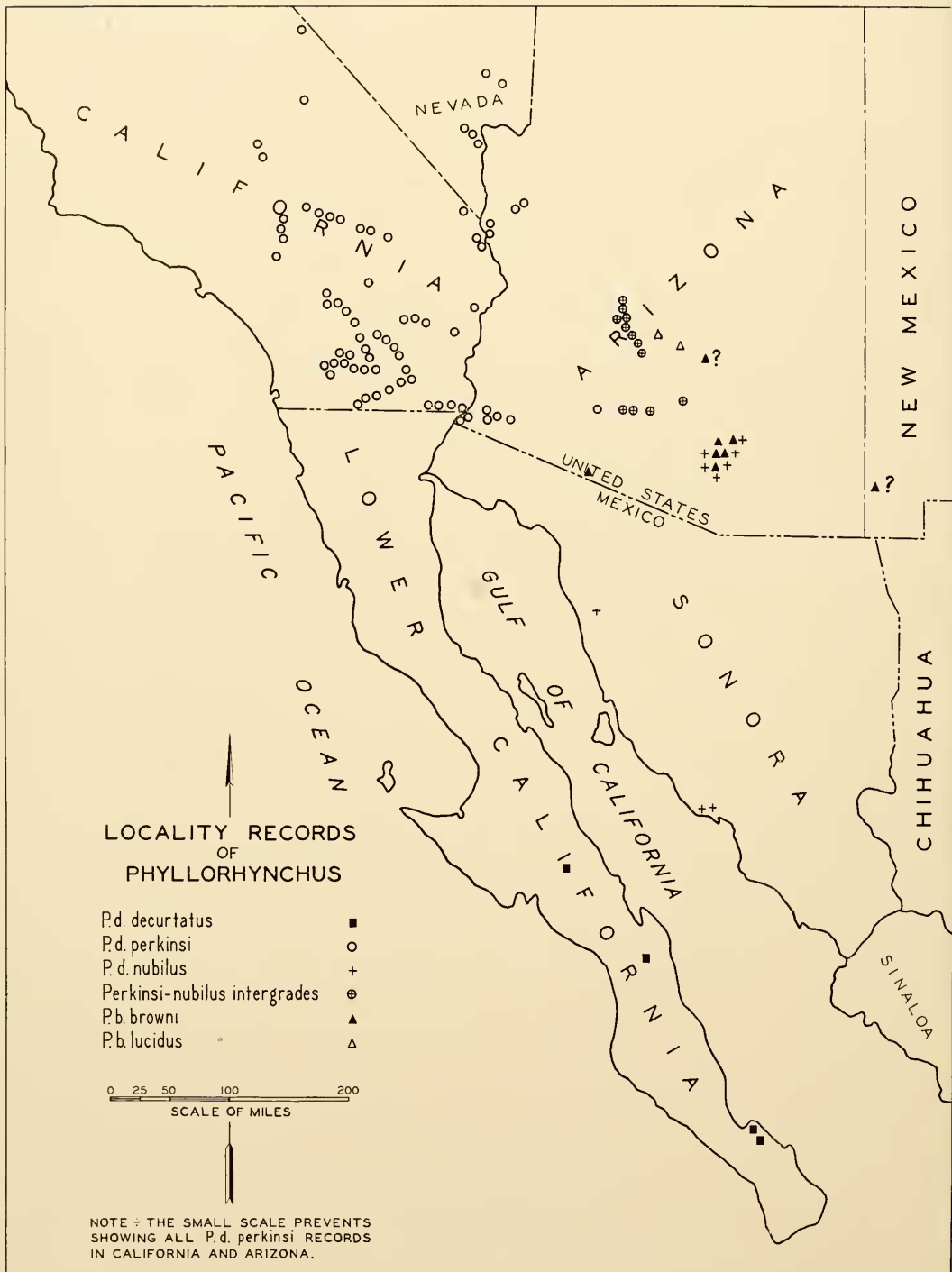
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TABLE OF CONTENTS

	<i>Page</i>
Introduction	197
A New Subspecies of <i>Decurtatus</i> from Near Tucson	197
A New Subspecies of <i>Browni</i> from Maricopa County	201
The Characters of <i>Phyllorhynchus browni browni</i>	204
Notes on <i>Phyllorhynchus decurtatus decurtatus</i>	206
Notes on <i>Phyllorhynchus decurtatus perkinsi</i>	207
Key to the Genus <i>Phyllorhynchus</i>	209
Acknowledgments	210
Summary	211

SAN DIEGO, CALIFORNIA

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INTRODUCTION

In 1935 I published¹ a survey of *Phyllorhynchus*, the leaf-nosed snakes, a genus of small, stubby snakes inhabiting the deserts of the southwest. Since then a considerable addition has been made to the available material, so that it is now possible to define the several forms with greater certainty in respect of their character dispersions. However, as a complete resurvey would involve much repetition of data contained in the prior report, I shall, in the present instance, confine my remarks to the changes and additions which the new specimens make possible; with regard to the other aspects of the genus, reference is made to the prior paper.

A NEW SUBSPECIES OF *DECURTATUS* FROM NEAR TUCSON

In the previous paper (p. 22) certain differences between the snakes from southern Lower California, belonging to the subspecies *decurtatus decurtatus*, and those from the vicinity of Tucson, Arizona, were pointed out, but a segregation was deemed inadvisable since only 13 specimens were at hand from both areas. Additional specimens have now been secured from the vicinity of Tucson, and these verify the differences from the Lower California material previously noted. The Arizona snakes are therefore allocated to a new subspecies

Phyllorhynchus decurtatus nubilus subsp. nov.

CLOUDY LEAF-NOSED SNAKE

Plate 8, fig. 1.

1922. *Phyllorhynchus decurtatus* (part) Schmidt, Bull. Am. Mus. Nat. Hist., Vol. 46, Art. 11, p. 685.

1933. *Phyllorhynchus decurtatus browni* Linsdale, Copeia, No. 4 of 1933, p. 222.

1935. *Phyllorhynchus decurtatus decurtatus* (part) Klauber, Bull. Zool. Soc. San Diego, No. 12, p. 9.

Type.—No. 32,493 in the collection of LMK, collected at Xavier (Weisner's Ranch), Pima County, Arizona, by Lee Arnold, at 9:45 P. M., July 16, 1939. Eleven paratypes are available from various points in Pima County, in the general vicinity of Tucson.

Diagnosis.—A subspecies of *P. decurtatus* distinguished from the typical subspecies by a high number of dorsal blotches and generally maculate appearance. Also, *nubilus* males have strongly keeled dorsal scales, while *P. d. decurtatus* males are keeled only faintly, if at all. From *P. d. perkinsi*, the new

¹ *Phyllorhynchus*, the Leaf-Nosed Snake, Bull. Zool. Soc. San Diego, No. 12, pp. 1-31, figs. 1-4, map. Sept. 12, 1935.

subspecies is differentiated by the relative sizes of the dorsal blotches and interspaces, the blotches being wider (longitudinally) than the interspaces in the new form. There are also differences in scalation, the new subspecies having fewer ventrals and subcaudals than *perkinsi*.

Description of the Type.—Adult male. Length over-all (prior to setting in preservative) 343 mm.; length of tail 48 mm., ratio of tail length to total length 14.0 per cent.

The scale rows are 21-19-17. The first suppression is at the neck and is effected by dropping the fourth row on each side; the second reduction is effected by combining the third and fourth rows. Except on the fore part of the body, the three rows on either side of the mid-dorsal are conspicuously keeled; the mid-dorsal itself is virtually smooth. Single apical scale pits are present. The ventrals number 157; the anal is entire; the subcaudals are 32, all divided.

The rostral is large and conspicuous, with raised and free lateral edges, which are striated. Below, the rostral is concave; viewed from above, it is straight across the front; on top it curves back over the snout, completely separating the internasals and intruding slightly between the prefrontals. The internasals are triangular; on the sides they contact the nasals and upper loreals. The prefrontals, of moderate size, are separated by a small scale on the mid-dorsal line. The frontal is large, curved in front and quadrangular behind, with a sharp point separating the parietals for about $\frac{1}{4}$ of their depths. The frontal does not contact the upper preoculars. The supraoculars are relatively small and are non-imbricate. The parietals are the largest of the head plates.

The nasals are divided; the prenasal is slightly the wider of the two, and the postnasal somewhat the higher. There are 4 loreals, one small supraloreal, a large mid-loreal, twice as high as wide, and two small sublореals, of which the posterior is the larger. There are two preoculars (higher than wide), two post-oculars, and three preoculars, thus making the complete ocular series eight on each side. The temporals are 2+3.

The supralabials are 7 on the right and 6 on the left; the last two are much the largest; the fourth to sixth, or fourth and fifth, contact the suboculars.

The infralabials are 9-9; the first pair meet on the midventral line; the first and fifth are the largest; the first two on each side touch the pregenials. The mental is wider than long, is sharply pointed posteriorly, and almost separates the first infralabials. The pregenials are short and subrectangular, about twice as long as wide; they are in contact. The postgenials are but little larger than the surrounding gulars; they are separated by two gulars, one before the other. There are six gulars between the pregenials and the first ventral, and six rows between the posterior infralabials and the first ventral.

This is a cylindrically-shaped snake with the head only slightly distinct from the body; the head is 14 mm. long, or 4.1 per cent of the body length. The tail is short and stubby. The pupil is vertically elliptical.

The everted hemipenes are triangular, with the greater width at the outer end. There is a deep central groove on either side, somewhat deeper on the side of the sulcus. The lobes are only slightly separated at the top; distally the sulcus branches sharply to the outer end of each lobe. On the top there are angular striations; these, at the outer edges, change into fringes, and then into spines

which increase in size proximally; at the base the spines are close together and evenly spaced.

The head is marked with a narrow dark-brown band, which crosses the posterior edges of the prefrontals, and thence passes backward across the eye, to the angle of the mouth. The rostral and internasals are spotted with gray, and there are spots on the nasals and the other scales on the side of the head. There is a large brown spot on the posterior half of the frontal, and scattered brown spots on the parietals and the head scales posterior thereto. The lower jaw is immaculate.

The body is covered with several series of highly irregular blotches, even the dorsal series, usually fairly regular in *Phyllorhynchus*, being broken up. As nearly as these blotches can be counted, there are about 59 in the dorsal series on the body and 11 on the tail. The dorsal blotches are dark brown, lightening distinctly toward the tail; usually they have light centers. The blotches are wider (along the body) than the interspaces. On the sides there are several additional rows of highly irregular spots, smaller than the dorsal series, with brown punctations interspersed between them. These continue down the sides to the second row of scales above the ventrals. Below, the tan ground color is immaculate.

Summary of the Subspecies.—The following eleven paratypes are available:

AMNH 20,590	San Xavier Mission
AMNH 60,112	3 mi. s. of Tucson
MZUM 64,068	Vicinity of Tucson
LMK 29,216	2 mi. n. of San Xavier Mission
LMK 29,287	4 mi. n. of San Xavier Mission
LMK 32,273	Ajo Junction (Escuela)
LMK 32,274	26 mi. n. of Tucson
LMK 32,289	4 mi. s. of Ajo Junction
LMK 32,290	2 mi. s. of Ajo Junction
LMK 32,468	E. base of "A" Mountain
LMK 32,494	5 mi. n. of Tucson

All of these localities are in Pima County, in the immediate vicinity of Tucson, with the exception of LMK 32,274, the locality of which is just across the line in Pinal County.

The scalation of the new subspecies, based on the available material (8 males and 4 females, including the type), may be summarized as follows: Scale rows, 19; ventrals, males 157 to 162, mean 158.5, coefficient of variation 1.1 per cent; females 171 to 176, mean 174.3, coefficient of variation 1.4 per cent; anal entire; subcaudals, males, 30 to 33, mean 31.6; females, 20 to 24, mean 21.3; supralabials predominantly 6 but often 7; infralabials 8 to 10; loreals 1 to 4; preoculars, 2 or 3; postoculars usually 2, occasionally 3; suboculars, 1 to 3, but usually 3; temporals 2+3, 2+4, 3+3, or 3+4; an azygous scale between the prefrontals in two out of ten specimens.

The tail length is about 14 per cent of the body length over-all in adult males, and 8 per cent in the females.

The largest specimen available is a female 408 mm. in length. The largest male is 343 mm. The smallest specimen measures 173 mm.

The patterns of all are much the same, except that occasionally a specimen is found with a more regular series of dorsal blotches. In such cases, however, the blotches, while somewhat reduced in number, still exceed those found in *P. d. decurtatus* and are closer together than in *P. d. perkinsi*, so that there is no difficulty in keying them out.

The body blotches vary from 42 to 60, average 50.4; tail spots 7 to 15, average 9.2.

Checking live specimens by the color standards of Ridgway, 1912, it was found that in one specimen the dorsal blotches were Warm Sepia on the edges and Snuff Brown in the center. The lateral blotches were Bistre on a Light Vinaceous-Cinnamon ground color. The ventrum was translucent White. In another specimen the blotch edges were Seal Brown with Hay's Brown centers. The lateral blotches were Sorghum Brown on a Pale Cinnamon-Pink ground color.

Like other species and subspecies of *Phyllorhynchus*, *nubilus* hisses and strikes when annoyed, and flattens the neck like a dewlap. The tongue is pink in life, almost colorless at the tip. The pupil is vertically elliptical, the iris flecked with green and gold. Specimens have been collected along the road at 9:40 P.M. (93° F.), 10:18 P.M. (84° F.), 11:20 P.M. and 2:25 A.M. This is probably a fairly common snake around Tucson, although somewhat rarer than *browni*, and considerably less common than the subspecies *decurtatus perkinsi* in some areas of the Colorado Desert in southern California. It seems to prefer brushy areas, particularly mesquite, and, to a less extent, salt bush and creosote bush. It is easiest collected by driving at night along paved roads, when the snakes will be disclosed by the headlights of the car as they cross the pavement. Lee Arnold, from whom most of the ecological notes on this subspecies were obtained, secured five specimens, 2 alive and 3 run over, in the course of 495 miles (31 hours) of driving in June and July of 1939.

Range.—I know of only one locality where this snake has been found, other than those previously given as the localities of the type and paratypes, this being the city of Tucson itself, where I found a large specimen run over on a city street just north of the business district. Specimens from other regions, possibly to be assigned to this subspecies, or considered intergrades, are discussed hereafter.

Relationships.—*Nubilus* seems to intergrade with both *perkinsi* and *decurtatus decurtatus*, but via different routes—with the former by way of central Arizona, and the latter through Sonora. The most extreme *decurtatus decurtatus* are not from the type locality, which is probably central Lower California,² but from the Cape region around La Paz. From the snakes of this region *nubilus* differs primarily in having (in the males) keels on the dorsal scales; and in body blotches and tail rings, which number only about half as many in *decurtatus decurtatus* as in *decurtatus nubilus*.

Four specimens are available from Sonora, Mexico: MVZ 10,170 from Alamo Muerto, and EHT 457, 723, and 1100 from near Guaymas (San Carlos Bay and La Posa). These are intermediate between *decurtatus nubilus* and *decurtatus decurtatus* in numbers of body blotches and tail spots; they more nearly

² Op. cit. p. 8.

resemble *nubilus* in the character of the blotches, and in possessing dorsal keels. They have fewer ventrals than either *decurtatus nubilus* or *decurtatus decurtatus*, being in fact, the lowest in this character of all available *Phyllorhynchus*. If this trend toward fewer ventrals is continued south of Guaymas, an additional subspecies would be warranted. However, for the present, the Sonora specimens are allocated to *nubilus*.

Through central Arizona, from Congress Junction, Yavapai County, to the vicinity of Casa Grande and Coolidge, Pinal County, a series comprising 24 specimens is available. These are intermediate between *perkinsi* and *nubilus*. *Perkinsi* differs from *nubilus* in having higher ventral and subcaudal scale counts, fewer and more widely separated dorsal blotches, head marks less evident, lateral blotches smaller and less prominent, and lateral interspaces less clouded. In all of these characteristics the central Arizona specimens are intermediate, which is entirely consistent and to be expected from a geographical standpoint. While recognizing these specimens as intergrades, for purposes of segregation in collections I would suggest their allocation to *perkinsi*, since most of them tend in that direction when classified by pattern. The localities where these intergrades have been found are as follows: *Yavapai County*—Congress Junction (also 2½ mi. n., 1½ mi. n., 3 mi. se., 8 mi. e., 9 mi. s.), and near Wickenburg (5 mi. n., 3 mi. nw., 6 mi. nw.); *Maricopa County*—Wickenburg (also 8 mi. w., 3½ mi. w., 4½ mi. w., 2½ mi. s.), Morristown (also 4 mi. n., 4 mi. s., 5½ mi. s.), Wittmann, and 29 mi. e. of Gila Bend; *Pinal County*—33 mi. e. of Gila Bend, 20 mi. w. of Casa Grande, and Coolidge.

There remains the question whether *nubilus* and *browni* are only pattern phases of the same species, as has been found to be the case with the king snakes of the San Diegan area in southern California. This is possible, for, with the limited material now available, no scale count differences can be demonstrated statistically. However, the absence of intermediates, such as characterize the king snakes, together with differences in blotch colors and head pattern, not evident in the king-snake complex, would indicate that such a relationship probably does not exist. The finding of females of *browni*, since the issuance of the previous paper, at least proves that the *browni* pattern is not an exemplification of sexual dimorphism. Upon the evidence so far available *decurtatus* and *browni* are to be considered separate species. A subspecific relationship is impossible since *decurtatus nubilus* and *browni* occupy the same territory. After all, the only evidence suggesting that *nubilus* and *browni* are pattern phases of a single subspecies lies in the similarity of their lepidosis in the Tucson area, and the tendency, which both have, toward higher ventral and subcaudal scale counts in specimens from the northwest, toward Wickenburg.

A NEW SUBSPECIES OF *BROWNI* FROM MARICOPA COUNTY

At the time the previous paper was written, only 8 specimens of *Phyllorhynchus browni* were available and these were all males. Now I have data on 35, of which 16 are females. It is therefore possible to define the variations in squamation and pattern more definitely. As a result I find sufficient differences in the only two specimens from Maricopa County, Arizona, to warrant their segregation as a new subspecies, to which I assign the name

Phyllorhynchus browni lucidus subsp. nov.

MARICOPA LEAF-NOSED SNAKE

Plate 8, fig. 2.

1935. *Phyllorhynchus browni* (part) Klauber, Bull. Zool. Soc. San Diego, No. 12, p. 17, fig. 3.

Type.—No. 28,819 in the collection of LMK, collected in Enchanto Valley, 7 mi. w. of Cave Creek, Maricopa County, Arizona. Received from V. Housholder, May 21, 1938. Paratype, a specimen in the collection of Earl Sanders, from 11 mi. east and 1 mi. north of Mesa, Maricopa County, Arizona, in the vicinity of Indian Wells.

Diagnosis.—A subspecies of *Phyllorhynchus browni* characterized by high ventral and subcaudal scale counts, and some modifications in pattern, as compared with the typical form. The differences in scutellation are shown by the following table, in which the statistics of the type and paratype of the new form are compared with those derived from 19 males and 15 females of *P. b. browni*. In each character under *browni*, the central figure is the mean and the outside figures indicate the range:

	<i>P. b. browni</i>	<i>P. b. lucidus</i>
Ventrals, males	156 - 158.8 - 164	172
females	168 - 172.3 - 178	182
Subcaudals, males	30 - 31.9 - 35	40
females	18 - 21.1 - 24	33

Description of the Type.—A juvenile female, length over-all (prior to setting in alcohol) 187 mm.; length of tail 18 mm.; ratio of tail to total length 9.6 per cent.

The scale rows are 21-19-17, smooth, and with single apical pits. The ventrals number 182; the anal is entire; the subcaudals, in twin series, number 33.

The rostral, very conspicuous, as is typical of the genus, has overhanging and grooved lateral borders. Below it is concave; above it curves back over the snout, completely separating the internasals and also the prefrontals for $\frac{1}{3}$ of their depth. The internasals are small and triangular. The prefrontals are moderate in size; they are followed by a very broad, pentagonal frontal which is proportionately wider than in *P. b. browni*; for, in the type of the new subspecies, the outer points almost contact the upper preoculars, whereas there is a wide separation between these scales in the specimens of the other form. The supraoculars are small and do not jut over the eyes. The parietals are similar to the frontal in size.

The nasal is divided into substantially equal parts by a suture slanting forward above. There are three loreals, an upper, middle, and lower; the upper is quite small and contacts the internasals and prefrontals; the second is the largest; the third is below and behind the second. There are two preoculars on the right and three on the left, two postoculars, and three suboculars. The temporals are 3+3, with a small extra scale cut from the anterior lower temporal on the left side only.

There are seven supralabials; the last two are the largest; the fourth and fifth contact the orbital scales. The infralabials are 9-10; the initial two are the largest and meet on the midventral line. The first three contact the pregenials, which are large and in contact; the postgenials are much smaller and are separated by a row of scales. There are 6 gulars between the pregenials and the first ventrals.

Like all of the genus this is a small stubby snake with a relatively short tail. The head is moderately distinct. The pupil of the eye is vertically elliptical.

The head is marked with chocolate brown on a cream background. There is a wide dark band across the anterior half of the frontal; this passes backward across the eyes to the angle of the mouth; from here it widens into two parallel bands on the neck, which join again dorsally about one head length behind the head. There is also a large dark blotch on the parietals; this blotch is not present in *P. b. browni* and is only rudimentary in the paratype of the new subspecies. There are dark punctations on the face and edges of the rostral, the nasals, and internasals, with a few scattered on the prefrontals and loreals.

On the body there is a series of 13 subcircular chocolate blotches. Longitudinally these cover slightly more space than the interspaces; on the sides they extend down as far as the second row of scales above the ventrals. The centers of the blotches are somewhat lighter than the edges, and, as the lighter color is restricted to scale centers, the blotches appear hatched with dark longitudinal lines. Laterally, between the blotches, there is a secondary series of small spots, longer than wide, engaging the first two lateral rows. Surrounding these there are a few dark punctations, reminiscent of the patches of punctations which characterize the lateral areas between blotches in *P. b. browni*. The ground color in the body is creamy-white, as is also the ventral surface. There are 3 dorsal spots on the tail.

The paratype, which is a juvenile male, has these characteristics: Length 247 mm.; tail 32 mm.; per cent tail 13.0. Ventrals 172, anal entire, subcaudals 40, supralabials 6-6, infralabials 9-9, loreals 3-3, preoculars 2-2, postoculars 2-2, suboculars 3-2, temporals 3+3. Body blotches 12, tail spots 4.

The parietal blotch on the head is rudimentary, and the parallel lines on the neck are missing. The dorsal blotches are relatively smaller than in the type, occupying less space than the interspaces. The secondary blotches are only faintly evident.

Remarks.—Besides the high ventral and subcaudal scale counts discussed in the diagnosis, the new form differs from *P. b. browni* in the large frontal, which almost touches the preoculars, in the head marks, and the body blotches. The body blotches in *P. b. browni* are usually indented laterally, and often approach a dumb-bell shape. In *lucidus* there are indentations on the mid-dorsal line, so that the paired lobes are transverse, rather than longitudinal as in *browni*. In some of these points the paratype of *lucidus* is intermediate between the type and *browni browni*. The frontal in the paratype is not so large, and, in its approach to the upper preoculars, is intermediate between the two. But, irrespective of the frontal and the pattern differences, and whether these will be substantiated when additional specimens are found, I judge, from the low coefficient of variation characteristic of *P. b. browni* and the subspecies of *P. decurtatus*, that the

difference in ventrals and subcaudals between the snakes of northeastern Maricopa County and those from Pima County will continue to warrant this subspecific segregation. For, in homogeneous series, the standard deviations of the ventrals are found to be 3 or less; and of the subcaudals below 2. The deviations of the two specimens of *lucidus* from the *browni* averages are more than three standard deviations in the ventrals, and more than four standard deviations in the subcaudals. Deviations of this magnitude are worthy of subspecific recognition, especially when reinforced by other differences.

Range.—At present the new subspecies is known only from the localities represented by the type and paratype. It will probably be found all along the bases of the mountains to the north and east of Phoenix. Extensive collecting in the Wickenburg area, northwest of Phoenix, from Morristown to Congress Junction, has failed to discover it. An MCZ specimen of *browni* from Superior, Pinal County, may be the new form; its condition is said to be such as to preclude securing any pertinent data.

THE CHARACTERS OF *PHYLLORHYNCHUS BROWNI BROWNI* PIMA LEAF-NOSED SNAKE

Plate 8, fig. 3.

At the time I last surveyed the genus *Phyllorhynchus* only 8 specimens of *browni* were available. All were males, and one of these has since been transferred to the new subspecies *lucidus*. It will be useful, therefore, to present the statistics of all the specimens of *browni browni* now available, numbering 19 males and 16 females:

The scale rows are 19. The ventrals in the males vary from 156 to 164, mean 158.8, interquartile range 157.5 to 160.0, coefficient of variation 1.16 per cent; in the females, range 168 to 178, mean 172.3, interquartile range 170.3 to 174.2, coefficient of variation 1.70 per cent. The anal is entire. The male subcaudals range from 30 to 35, mean 31.9, interquartile range 30.9 to 32.9, coefficient of variation 4.8 per cent; in the females, range 18 to 24, mean 21.1, interquartile range 20.0 to 22.3, coefficient of variation 7.9 per cent.

The supralabials are usually 6, often 7, rarely (one case only) 8. The infralabials are usually 8 to 9, rarely 10 or 11. The loreals are commonly 2 or 3, but occasionally 1 or 4. Both preoculars and postoculars are generally 2, but often 3. The suboculars are usually 3, sometimes 2. The temporals are generally 2+3, or 3+3, less often 2+4, or 3+4. There is an interprefrontal scale in 6 cases out of 27. The frontal does not contact the supraoculars. The body blotches, the most conspicuous character of this form, are distributed as follows (frequencies shown in parentheses): 9(1), 10(3), 11(12), 12(7), 13(9), 14(2), 15(1). The tail spots are distributed thus: 1(2), 2(21), 3(11).

The tail length in adult males averages about 13.5 per cent of the body length over-all; the ratio in the females is about 8 per cent.

The pattern is quite constant. The dorsal blotches are dark-brown to red-brown, nearly always longer than the interspaces, and often indented on the sides, sometimes to such an extent as to form longitudinal dumb-bells. The

first blotch is cut off squarely several scale rows back of the parietals. Laterally the interspaces are heavily punctated with dark spots, particularly at scale centers. These spots are faint in the young. In the main dorsal blotches, the centers are lighter than the edges. Sometimes there is a light spot in the center only. Where the centers are light they are sometimes striated longitudinally.

The head is marked across the prefrontals and anterior part of the frontal by a dark-brown bar, which passes downward and backward across the eyes to the angle of the mouth. The front and tip of the rostral are usually stippled, as are the lateral edges. The nasals are spotted, particularly around the nostril. There are often a few larger spots scattered about the frontal and parietal.

The colors of four specimens, compared, while alive, with Ridgway's Color Standards, 1912, were as follows:

Specimen Number	Outer Edges of Blotches	Centers of Blotches	Dorsal Interspaces	Spots in Lateral Interspaces ³	Ventrum
LMK 32,272	Vandyke Brown	Snuff Brown	Pale Pinkish Buff	Sayal Brown	White (translucent)
LMK 32,499	Warm Sepia	Sayal Brown	Light Pinkish Cinnamon	Tawny-Olive	"
LMK 32,495	Fuscous-Black	Natal Brown	White	Avellaneous	"
LMK 32,498	Fuscous-Black	Rood's Brown	Pale Pinkish Buff	Pinkish Cinnamon	"

The tongue is pink in life. The iris is flecked with gold; the pupil is vertically elliptical. When angered or annoyed, *browni*, like the subspecies of *decurtatus*, hisses quite loudly for so small a snake. It will strike, but one cannot be sure whether the mouth is opened. The threatening reaction includes a flattening of the neck into a sort of dewlap, quite thin in the horizontal direction.

Browni, as it is found in the vicinity of Tucson, seems to prefer brushy areas, especially mesquite, and, to a somewhat lesser extent, salt bush. While occasionally found under stones, or dug out in the course of excavations, it can best be collected by the method of driving along the road at night, as has been discussed elsewhere.⁴ Specimens have been collected in this way in June and July, at air temperatures of from 74 to 92 deg. Fahr. It has been taken at 8:10, 8:13, 8:30, 8:45, 9:00, 9:20, 9:30, 10:30, 10:50, 11:00, 11:10, and 11:57 P.M. There are indications that its season of greatest activity is somewhat later than that of *P. d. perkinsi* in southern California, the best collecting following the advent of the summer rains experienced in the part of Arizona where it occurs. It prefers somewhat humid nights. It seems to be a more plentiful snake than *nubilus*. Charles E. Shaw and Cyrus S. Perkins collected 9 specimens of *browni* (3 alive and 6 run over) in two evening drives around Tucson in mid-July, but only one *nubilus* was found.

³ The ground color is the same as the dorsal interspaces.

⁴ Studies of Reptile Life in the Arid Southwest. Part 1. Night Collecting in the Desert with Ecological Statistics. Bull. Zool. Soc. San Diego, No. 14, pp. 1-64, Feb. 24, 1939.

The largest specimen I have seen measures 396 mm., the smallest 166 mm. The largest individuals so far available are females. The largest male is 362 mm.; there are 6 females exceeding this size.

One *browni* had eaten a gecko egg; this is the same food so often found in the stomachs of *P. d. perkinsi*.

Browni browni has been collected at the following localities: *Pinal County*—Superior (may be *lucidus*); *Pima County*—Sabino Canyon; mouth of Sabino Canyon; foothills of Santa Catalina Mountains northeast of Tucson; 3, 4, and 8 miles southwest of Sabino Canyon, on the road to Tucson; Wrightstown; 7 and 11 miles northeast of Tucson, on the Sabino Canyon road; foot of Santa Catalina Mountains; 13 miles north of Tucson; 8 and 10 miles south of Oracle Junction on the road to Tucson; 6 and 11 miles north of Tucson on the road to Oracle Junction; Tucson; foot of "A" Mountain; Ajo Junction (Escuela); 1 and 4 miles south, and 4 miles north of Ajo Junction; San Xavier Mission, and 2 and 3 miles north of the Mission; Xavier (Weisner's Ranch); 11 miles south of Tucson on the Nogales road; 2 miles east of Dowling Well, Sonoita Valley.

All of these Pima County records are within a radius of 20 miles of Tucson, most of them close to the city, with the exception of the last. This represents a western extension of the range by more than 100 miles. The specimen was collected by L. M. Huey on an expedition to the Organ Pipe Cactus National Monument. The New Mexico record mentioned by Medden (Copeia, 1927, No. 64, p. 82) still remains unverified.

Since the specimen of *browni* figured in the previous paper has now been allocated to the new subspecies *lucidus* (it is the paratype of the new form), a photograph of *browni browni* is included in Plate 8, fig. 3.

NOTES ON *PHYLORHYNCHUS DECURTATUS DECURTATUS* LOWER CALIFORNIA LEAF-NOSED SNAKE

Through the courtesy of the American Museum of Natural History I have seen two additional specimens of *decurtatus decurtatus*. This makes a total of 8 of this form available, 4 from the Cape region, the rest from the central part of the peninsula of Lower California. Five are males. It is to be understood that this subspecies, as redefined, occurs only in Lower California, Mexico. As previous descriptions were based, in part, on specimens now allocated to other subspecies, I think it best to present a brief summary of *decurtatus decurtatus* as restricted.

The scale rows are 19. Keels are faintly evident in some of the largest males. The ventrals in the males vary from 157 to 167 and in the females from 167 to 176. Cape specimens have fewer ventrals than those from farther north. The subcaudals range from 33 to 36 in the males and 22 to 26 in the females. The supralabials usually number 6, but may be 5 or 7; the infralabials are 8 or 9, rarely 7. The loreals number 1 to 3; preoculars usually 2, but sometimes 3; postoculars 2 or 3; suboculars 1 to 3, usually 3. The temporals vary from 2+3 to 3+4.

In the southern part of the range the blotches are subcircular, but farther north they approach a rectangular shape. They are longer than the interspaces, and are dark brown on a pinkish background. The blotch centers are lighter

than the edges. The dorsal blotches number 18 to 33, average 24.6; the tail spots 2 to 8, average 5.1. Southern specimens have the fewest blotches.

NOTES ON *PHYLLORHYNCHUS DECURTATUS PERKINSI*
DESERT LEAF-NOSED SNAKE

Since the publication of the 1935 paper, a large amount of additional *decurtatus perkinsi* material has come to hand, over 350 specimens being now available. Many new localities are known, but as none extend the range, they will not be listed. Statistical data on this subspecies, including seasonal fluctuations, time of activity, the effect of temperature, and ecological preferences, will be found discussed in the 1939 paper previously mentioned. The outstanding fact developed is the commonness of this snake, once considered rare. For example, out of 279 live snakes encountered on the roads of San Diego County while driving 2985 miles at night on the desert, 110, or almost 40 per cent, were leaf-nosed snakes. On the night of June 9, 1939, fifteen live specimens and 3 which had been run over were collected in driving 21 miles on the Sentenac-Dry Lake road. Certainly this is the most plentiful snake in many desert regions of the Southwest, particularly where there is a good cover of brush and the ground is somewhat stony.

Specimens exceeding 400 mm. are quite common; the largest measured to date are a male 495 mm. and a female 486 mm. in length, both from San Diego County. These are live measurements.

It appears that in this subspecies the males slightly exceed the females in length. Taking all southern California specimens over 300 mm., we find the males to average 389 mm., and the females 371 mm. Fifteen males out of 120 exceed 460 mm., while only 4 females out of 76 are this large.

Most of the females with eggs contain 3 or 4.

The snakes from the northern and western limits of the range have the highest ventral scale counts. There is a decline eastward toward the eastern part of the Mohave Desert, which becomes even more marked after crossing the Colorado River into Arizona. The lowest figures for the subspecies are reached in the *nubilus* intergrades, in the vicinity of Wickenburg and Casa Grande. But in any one area the scale formulas have low dispersions, as is usually the case with small, slow-moving forms. For example, the statistics of 126 males and 99 females from the region of the type locality in eastern San Diego County are as follows:

	<i>Males</i>	<i>Females</i>
Ventrals, range	168-182	181-196
interquartile range	172.4-176.6	185.8-189.7
mean	174.48	187.76
coefficient of variation, %	1.77	1.54
Subcaudals, range	32-41	24-34
interquartile range	36.1-38.7	27.7-30.2
mean	37.41	28.93
coefficient of variation, %	5.05	6.39

Phyllorhynchus is a genus notable for an extensive sexual dimorphism in ventrals and subcaudals, there being almost no overlap. In this connection I would mention a statistical criterion which may be suggested to describe the degree of such divergences as are exemplified by sexual dimorphism. It appears to me that a measure of difference somewhat similar to the coefficient of variation would be useful in comparing the extent of differences, where the bases of comparison are dissimilar. While methods of determining the significance of differences are well known and extensively used, this is not the same thing as the extent of a difference; very small differences may be highly significant if the samples are large. For the determination of significance is only a calculation of the probability that the difference might have arisen solely from the fortuitous composition of the samples available, rather than from a real difference between the populations from which the samples were drawn. I do not find a statistic, suitable for measuring or comparing differences by reducing them to an absolute basis, in any of the texts available to me, including the recently published Statistical Dictionary of Terms and Symbols, by Kurtz and Edgerton, 1939. I therefore suggest, with no presumption respecting its originality, as a Coefficient of Divergence, the difference between the means, divided by the mean of the means, with the result expressed as a percentage; that is, if the means of the two samples be M and M' respectively, the coefficient of divergence, $CD=100(M-M') / [(M+M') / 2]$ or $CD=200(M-M') / (M+M')$ in per cent.

For example, sexual dimorphism in ventrals and subcaudals is very marked in *Phyllorhynchus*, much more so than in *Lampropeltis*. In the statistics of the San Diego County specimens of *Phyllorhynchus decurtatus perkinsi*, given above, we have the following means: ventrals, males 174.48, females 187.76; subcaudals, males 37.41, females 28.93. From these data we calculate the coefficient of divergence (in this instance a measure of sexual dimorphism) as 7.33 per cent for the ventrals and 25.57 per cent for the subcaudals. From large samples (147 males, 124 females) of *Lampropeltis getulus californiae*, we derive the following means: ventrals, males 233.01, females, 235.04; subcaudals, males 56.01, females 52.07. In this case the coefficient of divergence of the sexes proves to be only 0.87 per cent for the ventrals and 7.29 per cent for the subcaudals. These are much lower figures than were found for *Phyllorhynchus*, and I think it fair to say, first, that *P. d. perkinsi* exhibits a greater sexual dimorphism in these characters than *L. g. californiae*, and that both show higher dimorphism in subcaudals than in ventrals.

Let us take another type of difference—a territorial divergence. How does the divergence in the ventrals of male *Crotalus viridis viridis* from Colorado and South Dakota, respectively, compare with the divergence in body blotches? We cannot compare directly the actual mean differences since the ventrals average about 177 and the blotches only about 43. Using the Platteville and Pierre series from these states, each numbering several hundred specimens (data cited in Occ. Pap. S. D. Soc. Nat. Hist., No. 3, p. 34), we find that the coefficient of divergence between these populations (males only) is 1.17 per cent in the case of the ventrals and 3.55 per cent for the body blotches.

As has been stated, this coefficient of divergence is an absolute quantity, divorced of the unit of measurement, in the same manner as is the coefficient of

variation. It does not in itself give any indication of significance, or the probability that even a relatively high coefficient might have resulted from chance in sampling. For those who are accustomed to think of the significance of a difference between means in terms of the ratio of the difference to its standard error, and the interpretation of that ratio in a table of areas of the normal curve, this statement can be carried forward into the coefficient of divergence by also dividing the standard error by the mean of the means. Thus, in the case of the male ventrals of the Platteville and Pierre series of rattlesnakes, we determined (loc. cit.) 2.082 ∓ 0.223 to be the difference between the means. The ratio of the difference to its standard error is 9.3, indicating a highly significant difference. The mean of the means is 177.82. Multiplying 2.082 ∓ 0.223 by 100 and dividing by 177.82, we have, as the coefficient of divergence, 1.17 ∓ 0.125 per cent. Thus the ratio of 9.3, between the first quantity and its standard error, has been carried forward to continue the indication of the significance of the difference being investigated. [In this instance the significance of the difference was calculated by the customary method of dividing the difference between the means by the square root of the sum of the squares of the standard errors of the means. If one prefers an alternative formula (Kenney: Am. Math. Monthly, Vol. 45, p. 456, 1938; Mathematics of Statistics, Vol. 2, p. 141, 1939; Simpson and Roe: Quantitative Zoology, p. 192, 1939), the result can be carried forward in the same way. Even the *t*-test result, derived from the method of pooling, may be translated into an equivalent ratio on the normal curve and carried forward].

KEY TO THE GENUS *PHYLLORHYNCHUS*

- A. Dorsal body blotches (not including tail spots) less than 17.
- B. Males with 166 or fewer ventrals and 36 or fewer subcaudals; females with 179 or fewer ventrals and 26 or fewer subcaudals. Body blotches considerably longer than the interspaces. *P. browni browni*
(Southeastern Pinal County and eastern Pima County, west to Organ Pipe Cactus National Monument, Pima County, Arizona)
- BB. Males with 167 or more ventrals and 37 or more subcaudals; females with 180 or more ventrals and 27 or more subcaudals. Body blotches little, if any, longer than the interspaces. *P. browni lucidus*
(Northeastern Maricopa County, Arizona, along the mountain bases, from near Cave Creek to Indian Wells)

- AA. Dorsal body blotches (not including tail spots) 17 or more.
- C. Males with 168 or more ventrals; females with 179 or more. Body blotches usually distinctly narrower (along the body) than the interspaces. *P. decurtatus perkinsi*
(Southern California, on the eastern or desert side of the mountains, from the Death Valley region south to northeastern Lower California; also central Clark County, Nevada, southeast through Mohave, western Maricopa, and Yuma Counties, Arizona, to extreme northwestern Sonora, Mexico. Intergrades with *P. d. nubilus* in the area from southwestern Yavapai County to western Pinal County, Arizona)
- CC. Males with 167 or fewer ventrals; females with 178 or less. Body blotches usually equal to or wider (along the body) than the interspaces.
- D. Dorsal body blotches (not including tail spots) 34 or less; males without conspicuous keels on the dorsal scales.
..... *P. decurtatus decurtatus*
(Central and southern Lower California. Probably intergrades with *P. d. perkinsi* in north-central Lower California)
- DD. Dorsal body blotches (not including tail spots) 35 or more; males with conspicuous keels on the dorsal scales.
..... *P. decurtatus nubilus*
(Vicinity of Tucson, Pima County, Arizona; west-central and northwestern Sonora, Mexico)

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private collection of Wm. Woodin, III; and the University of Arizona. Where particular specimens have been referred to in the text, the initials of the museum, as cited, are given above.

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SUMMARY

Recently a number of additional specimens of leaf-nosed snakes of the genus *Phyllorhynchus* have been available, thus permitting a more complete knowledge of the specific variations. Two new subspecies, *P. decurtatus nubilus* and *P. browni lucidus*, are described from southern and central Arizona. The other subspecies are redefined and a key to the genus is supplied.

PLATE 8

Fig. 1. *Phyllorhynchus decurtatus nubilus* subsp. nov. Type specimen. Adult male collected at Xavier, Pima County, Arizona. ($\times 1.5$).

Fig. 2. *Phyllorhynchus browni lucidus* subsp. nov. Type specimen. Juvenile female collected in Enchanto Valley, Maricopa County, Arizona. (Life size).

Fig. 3. *Phyllorhynchus browni browni* Stejneger. Adult female collected at Escuela, Pima County, Arizona. ($\times 0.9$).

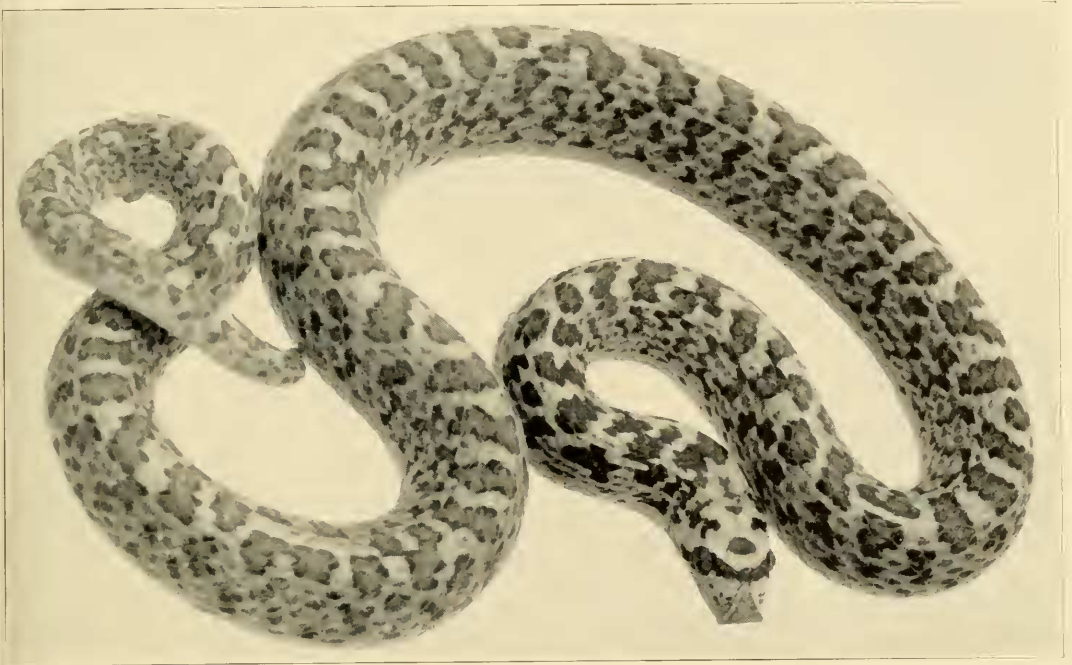


Fig. 1.

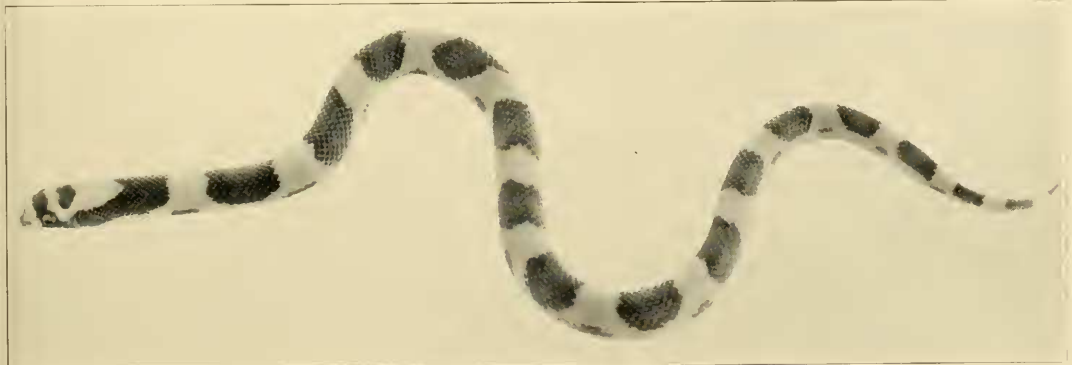


Fig. 2.

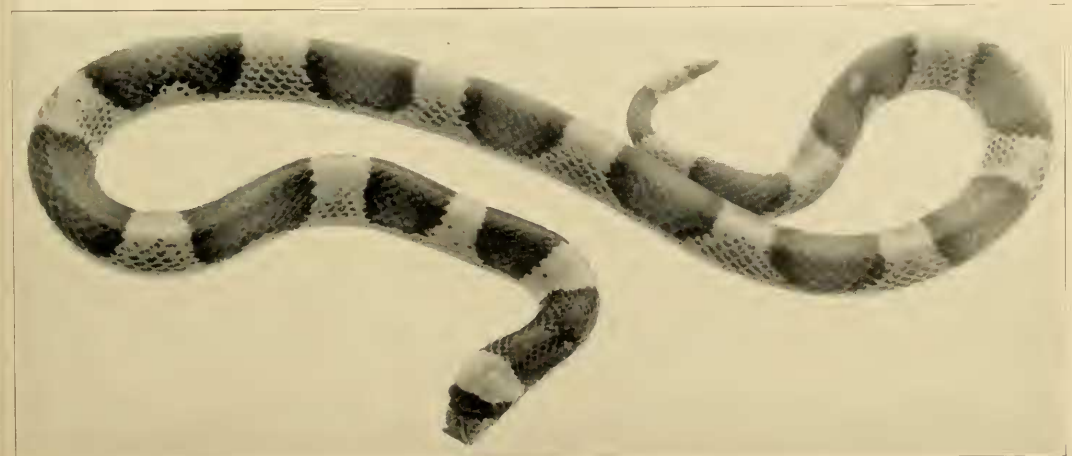


Fig. 3.

